

FLEX

A STUDY OF FLEXIBILITY CONTAGION SPECIAL EDITION

Research Partners

Center for Advanced Design
Research and Evaluation (CADRE)
HKS, Inc.

Team Members

Upali Nanda, Deborah Wingler,
Melissa Hoelting, Kate Renner,
Frank Kittredge, Whitney Fuessel

Advisors

Jason Schroer, Stan Shelton,
Erin Peavey, Alison Avendt,
Sarah Holton, Arthur Brito

The Challenge

What is a pandemic and how does it affect the architecture, engineering and construction industry?

According to the [World Health Organization](#), a pandemic is declared when a new disease for which people do not have immunity spreads around the world beyond expectations. Emerging infectious diseases (EIDs) such as Ebola, influenza, SARS, MERS, and, most recently, coronavirus (2019-nCoV) [cause large-scale mortality and morbidity, disrupt trade and travel networks, and stimulate civil unrest](#).

When local emergence leads to regional outbreaks or global pandemics, the economic impacts can be devastating. [The processes that drive disease emergence risk](#) interact with those necessary to achieve multiple societal goals. Because pandemics, especially like the ones we are facing today, have an incredible spread rate, it requires us to increase our surge response in operations and buildings rapidly.

The aim of this special edition is:

1. To understand the flexibility (and flow) needs that must be met during a pandemic
2. To clearly illustrate how flexibility is being deployed today, using the FleXX framework, and outline a process for prioritization of flexing capital assets
3. To lay the groundwork for post-surge preparedness, and long-term flexibility

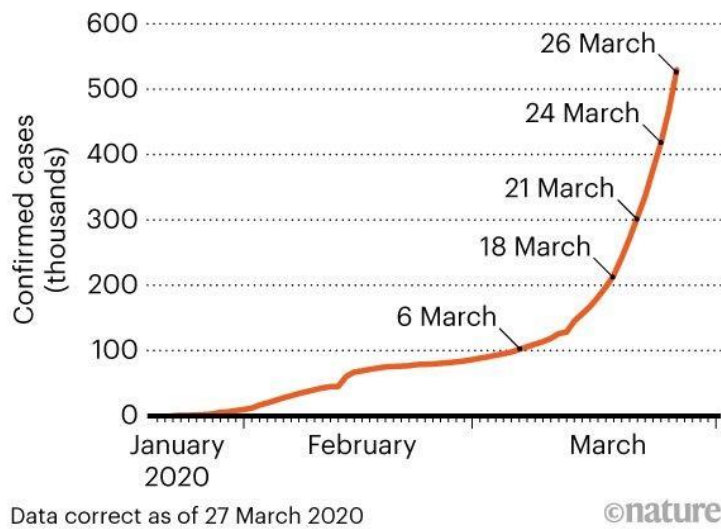
Flexibility Needs During a Pandemic

[The speed of an epidemic depends on two things](#) -- how many people each case infects and how long it takes for infection between people to spread. The image below shows how rapid the growth of a pandemic like the coronavirus has been and how quickly it can spread.

Figure 1—Coronavirus infection rates

HALF A MILLION INFECTIONS

There have been more than 500,000 confirmed cases of coronavirus worldwide. It took 67 days for the 100,000 cases to be reported, but just 3 days to go from 400,000 to 500,000 cases.



Retrieved from: <https://www.nature.com/articles/d41586-020-00154-w>

From an emergency management and preparedness perspective, this rate of change, escalating daily, is also distinct to a pandemic compared to a natural disaster where you experience the conditions once- and then deal with the aftermath. The issue of **flow, and rapid surge capacity growth**, make pandemics need a unique kind of flexibility.

In the case of the coronavirus, early reports suggest person-to-person transmission most commonly happens during close exposure to a person infected with COVID-19, primarily via respiratory droplets called aerosols or droplet nuclei produced when the infected person coughs or sneezes. Droplets can land in the mouths, noses, or eyes of people who are nearby or possibly be inhaled into the lungs of those within close proximity. Although the exact mechanism for how COVID-19 transmission occurs is currently uncertain, airborne transmission from person-to-person over long distances is unlikely. To **contain** the transmission of and EID such as coronavirus, the [CDC includes three critical steps](#):

- **Limit how germs enter the facility.** Cancel elective procedures, use telemedicine when possible, limit points of entry and manage visitors, screen patients for respiratory symptoms, encourage patient respiratory hygiene using alternatives to facemasks (e.g., tissues to cover cough).
- **Isolate symptomatic patients as soon as possible.** Set up separate, well-ventilated triage areas, place patients with suspected or confirmed COVID-19 individuals in private rooms with closed doors and private bathroom (as possible), prioritize Airborne Infection Isolation Rooms (AIIR) for patients undergoing aerosol-generating procedures.
- **Protect healthcare personnel.** Emphasize hand hygiene, install barriers to limit contact with patients at triage, cohort COVID-19 patients, limit the numbers of staff providing their care, [implement PPE optimization strategies](#) to extend supplies.

Simultaneously health systems need to prepare for the massive surge- which puts stress on every single part of the health system and the overall community. [Projections have been made](#) that reveal how well-equipped existing systems are to handle the expected need. These projections suggest that for the vast majority of health systems, rapidly flexing within their existing facilities will no longer be enough. We will rapidly need to start leveraging community resources: sports facilities, convention centers, hotels, dorms etc. Quickly, pandemics become a public health challenge that require incredible flexibility in our buildings- across all typologies.

In addition to mandating social distancing, governments across the globe are working at national and state levels with health systems to increase testing capabilities.

By first keeping the screening out of the hospital, they are following the principles of limiting, and isolating. Once home-tests are available, healthcare worker protection will exponentially increase. In the meanwhile, the first surge need that must be addressed is before the hospital visit itself.

Prevention, Testing & Screening (Pre-Hospital)

Countries across the globe are working on methods for containing the virus, rapid testing and triaging, while protecting the hospital where critical patients are being treated. This has resulted in the deployment of strict social distancing and quarantining protocols at the community level, as well as deployment of isolation & virus containment centers with available community resources like hotels that are currently low on occupancy.

Simultaneously, drive-through testing as well as converted parking lots and large public gathering areas like convention centers are being deployed for testing and screening.

Treatment (Hospital)

Hospitals need to rapidly respond to immediate needs and prepare for worst case scenarios when facing a pandemic. They prepare by moving all care possible to a virtual environment, releasing patients, and cancelling all elective surgeries in order to increase availability of patient beds and PPE.

The overall goal is to increase capacity to address the upcoming, exponential demand, for both isolation and critical care. Alternative care facilities (ACFs) play a crucial role in a pandemic, adapting non-traditional venues, such as hotels or schools, to increase capacity and allow healthcare environments to focus on high-acuity cases by providing lower-acuity care, testing/screening, quarantine/isolation space, etc. Traditional healthcare environments may need to adapt to address flow and increase capacity wherever possible in their existing spaces.

The Harvard's Global Health Institute [produced a robust overview of the crisis](#) in bed needs and the need for facilities to rapidly flex up their capacities. However- bed needs may vary significantly across systems based on the demographic, co-morbidities, and level of exposure. In addition to regional projections, it is important that projections for specific health systems are considered.

Figure 2— Estimation of hospital bed requirements during COVID-19 pandemic.

Number of hospital regions that may have to free up (or add) ...

	No beds	Between 1% and 100% of occupied beds	More than 100% of occupied beds	No I.C.U. beds	Between 1% and 100% of occupied I.C.U. beds	More than 100% of occupied I.C.U. beds
If 20% of adults are infected						
Over 18 months	231 (out of 305)	74	0	38	243	24
Over 12 months	101	203	1	2	166	137
Over 6 months	6	178	121	0	11	294
If 40% of adults are infected						
Over 18 months	47	246	12	1	86	218
Over 12 months	6	178	121	0	11	294
Over 6 months	0	10	295	0	0	305
If 60% of adults are infected						
Over 18 months	8	181	116	0	13	292
Over 12 months	0	47	258	0	0	305
Over 6 months	0	0	305	0	0	305

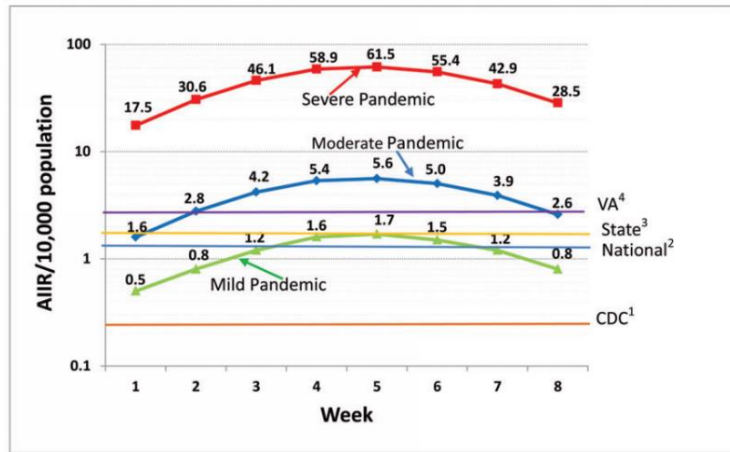
Note: There are 306 hospital referral areas in the United States, but there was not enough data to include the Panama City, Fla., area in the analysis. - Source: Harvard Global Health Institute estimates of hospital bed capacity and Covid-19 infections

Retrieved from: <https://www.nytimes.com/interactive/2020/03/17/upshot/hospital-bed-shortages-coronavirus.html>

Modeling helps to determine when additional capacity of the various locations across a health system will be needed, as well as how many critical key planning units (KPU's) will be required [All Rooms, Acute Care or Medical/Surgical beds; ICU beds; ventilators; etc.].

Health systems are updating these models daily as they prepare for the surge and assess what “out of hospital” locations as well as, how many ACFs will be needed, and for how long.

Figure 3—AIIR need estimates for mild, moderate, or severe pandemic scenarios with an 8-week wave duration



¹ CDC recommended minimum AIIR capacity
² Available national capacity
³ Available state capacity
⁴ AIIR capacity in VA medical facilities

Retrieved from: <https://www.liebertpub.com/doi/pdfplus/10.1089/hs.2016.0015>

Current models at the national and county level are daunting, suggesting health systems will need to more than double available inpatient beds to care for those in need of hospitalization. However, these models lack the nuance of regional context. The key variables that influence an informed calculation of building up a hospital’s capacity are:

- Doubling rate [or reproduction rate] of the virus
- Hospital admission rate
- ICU admission rate
- M/S and ICU length of stay
- Available M/S ad ICU beds
- Available ventilators
- Assumptions regarding the % of the population that will be infected to determine when the visits will peak in a region

Of these variables, the most influential indicator for predicting when a health system will reach capacity is the doubling rate, which can vary greatly across geographic regions. Health systems are updating these models daily as they prepare for the surge and assess what “out of hospital” locations as well as, how many ACFs will be needed, and for how long.

Post-Acute/Palliative Care Needs (Post-Hospital)

To date, the challenges associated with treating and caring for the surge in critically ill patients has been the primary focus of efforts around the world. However, little attention has been given to the post-acute recovery needs of those who survive. While it is still too early to know the long-term effects of coronavirus on survivors, in the short term many survivors will need post-acute care once discharged from the hospital to assist with recovery before transitioning back to the home or when transitioning to their home environment. In their [recent viewpoint column in JAMA](#), Gabrowski and colleagues suggest one way to mitigate the spread of COVID-19 within existing post-acute care facilities while caring for patients recovering from coronavirus would be to convert or expand existing post-acute care facilities into specialized COVID-19 post-acute care centers. They also advocate for policy changes to allow home health care reimbursement to include the provision of institutional level services in the home. As we begin to shift our focus from treatment to rehabilitation, it will be essential to determine how to best accommodate this new influx of patients into the healthcare system both now and in the future.

Although many critically ill COVID-19 patients will recover, it is inevitable that many will not survive. [Recent projections](#) suggest that between 100,00 to 200,000 people will die in the U.S. due to the coronavirus outbreak. For many of these individuals, [they will lack the comfort of being with loved ones during their final moments due to restrictions that prohibit visitors or family members from entering most hospitals](#). In this time, extending human kindness and caring for others physical, emotional, and spiritual needs has never been more important. The way we design our traditional facilities and ACFs and operationalize end of life care during a pandemic can greatly support these efforts.

Caring for the dead during a pandemic also poses unique challenges to an already overburdened system. As the number of deaths rapidly increase, areas with the greatest influx of critically ill COVID-19 patients such as New York are running out of space to care for the deceased. Morgues are at full capacity and alternative methods for storing the deceased in temporary morgues such as refrigerated trucks and tents [are already being utilized](#). With visitation to hospitals suspended and quarantine orders in place, grieving families also face additional challenges of not being able to hold a funeral for their loved ones. It is crucial during a pandemic for healthcare systems to consider not only how they will plan for a surge in critically ill patient but also for storing and handling the deceased.

The Solution

Deploying Flexibility: From rapid response, to mid & long-term planning

“Flexibility is far more than a facility concern; it affects facilities’ ability to accommodate changing operational and functional needs’ (18). Additionally, a facility must accommodate emergent and unexpected needs that may be due to catastrophic events such as having surge capacity, which is defined by the American College of Emergency Physicians, as the measurable ability to manage a sudden influx of patients” ([FleXX Report](#))

In our 2019 study, “FleXX: A Study of Flexibility in outpatient settings”, a set of attributes of flexibility was identified from existing frameworks in the literature. From Monahan’s framework, flexibility was deconstructed into five spatial properties including versatility, modifiability, convertibility, scalability, and fluidity. Versatility, modifiability, convertibility, and scalability were identified attributes throughout frameworks found in existing studies related to the built environment, while fluidity was not.

Figure 4—Flexibility attributes from Monahan’s framework

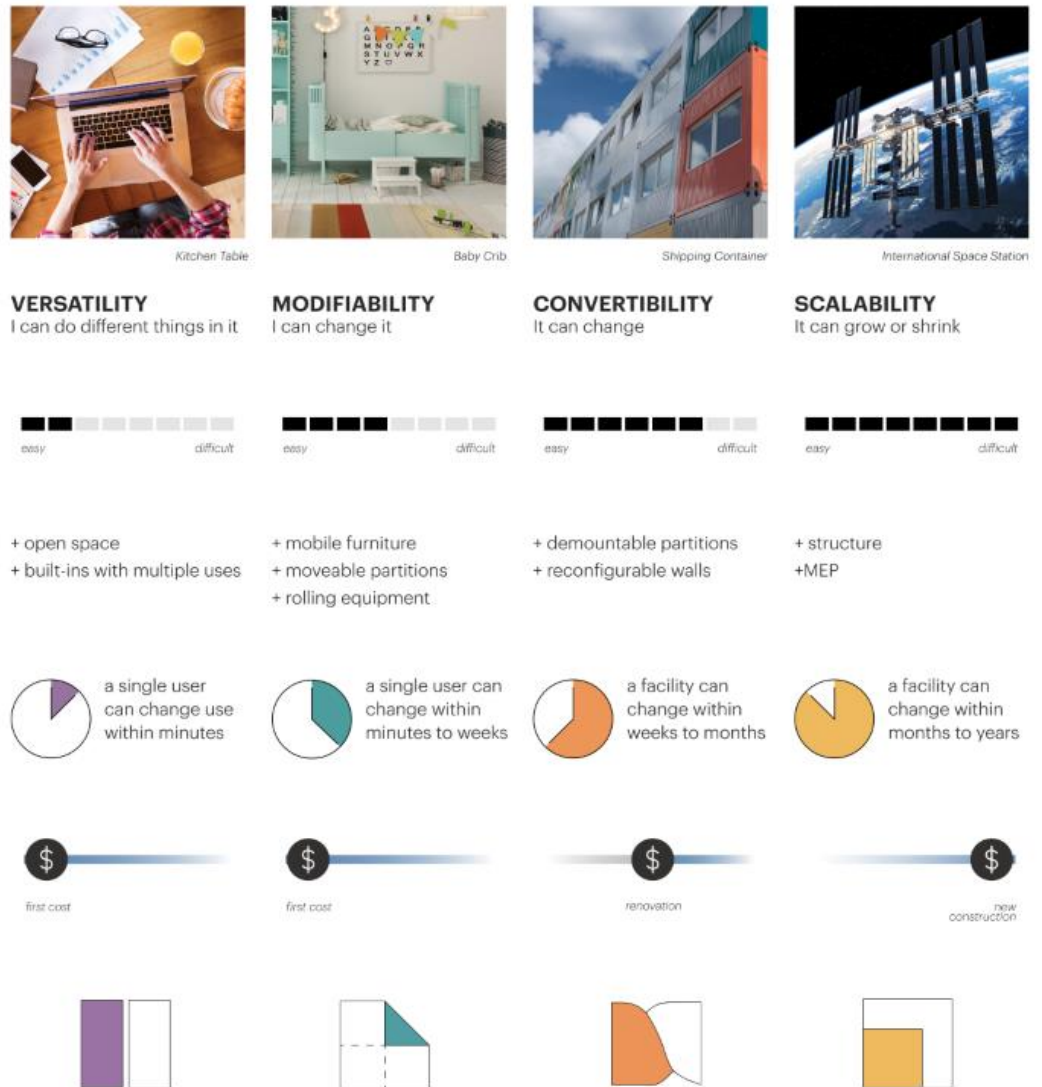


Information Source: Monahan [14]

Retrieved from: <http://www.cadresearch.org/flexx>

The resulting FleXX framework aligns the four attributes of flexibility in the built environment, on a spectrum, detailing type of change, agency of the user or facility to make that change, ease of change, cost of change, timeframe of change, and state change for each.

Figure 5—FleXX framework



Retrieved from: <http://www.cadresearch.org/flexx>

This framework was developed and tested by filtering real-life projects (health care and analogous) through it, working to establish clear differentiations between attributes. As we are considering this FleXX framework in pandemic situations, we again must filter associated design strategies through it to understand and develop it even further. Examples should include both traditional health care facilities and ACFs.

To capture these examples, we consider each attribute as originally defined in the FleXX framework, with responding strategies categorized as:

- Versatility - allows for **immediate multifunctional use**, requiring no physical modifications.
- Modifiability – can be **manipulated quickly**, potentially for different uses, by modifying the infill of the built environment. This includes mobile partitions, moveable furniture, etc., requiring **little to no infrastructure changes**.
- Convertibility - adapts for new uses and affords easier future re-design by converting the base of the built environment. This includes reconfigurable walls, added/modified MEP, etc., requiring **infrastructure changes**.
- Scalability – can expand or contract through new or temporary construction. This includes, temporarily built facilities, rapid construction, pre-fab modules, etc.

Scalability is the core need of pandemic response. It encompasses all flexibility needs or overarching goals – the built environment, staff, and resources, must scale to increase capacity to respond to demand on the healthcare system. However, design and operations may accomplish this increase in capacity through the deployment of any of the four attributes of flexibility listed above.

To track the deployment of flexibility in response to COVID-19 across the globe, we are capturing a variety of case studies. These outline flexibility strategies for each attribute, occurring from the facility level to across the globe. Please help us to understand how flexibility is being used by adding examples, that you are a part of or have found, to our [live excel sheet](#).

Below you will find a table synthesizing flexibility strategies for both HCs and ACFs that have been identified to date.

Figure 6 —Deploying flexibility in a pandemic situation

FleXX	Versatility	Modifiability	Convertibility	Scalability
	<i>No physical modification; new functionality</i>	<i>Minor modification with movable components</i>	<i>Major modification with infrastructure changes</i>	<i>Expand/contract with new or temporary construction</i>
Healthcare Facilities (HC)	<ul style="list-style-type: none"> • Split Flow of Public vs. Patient via existing horizontal and vertical circulation • Refrigerated Trucks as Morgues • Screening at parking lot entries 	<ul style="list-style-type: none"> • Lobbies as Screening Facilities by using mobile screens • Tents in parking lots for triage • ORs/ Minor Procedure Rooms/ Cath labs converted to negative pressure rooms for Isolation • Outpatient Clinics as Triage Facilities or low acuity ED Expansion • Private patient rooms to semi-private 	<ul style="list-style-type: none"> • Parking Garages converted to hospitals • Sections of ICUs converted to Isolation Units • Public Lobbies converted to Patient Rooms 	<ul style="list-style-type: none"> • Shell spaces built out before schedule • Portions of new construction deployed early for COVID • Modular Hospitals/Units • Deployment of Navy Hospital Ships • Reopen previously closed hospitals • Rapidly built, temporary hospitals
Alternative Care Facilities (ACF)	<ul style="list-style-type: none"> • Hotels, student dorms, churches, rental cabins, RVs, etc. used for containment/ isolation • Hotel/ Dorm/ Community kitchens used for increased food services needs • Large refrigeration facilities used for morgues 	<ul style="list-style-type: none"> • Tents in parking lots for drive-in testing • Mobile partitions to set up triage stations in lobbies • Pop-up phone booths for safer testing • Exhibition halls/ wedding venues as testing centers 	<ul style="list-style-type: none"> • Convention Centers converted to Hospitals. • Hotels converted to Hospitals. • Stadiums converted to Hospitals 	<ul style="list-style-type: none"> • 3D printed rapidly deployed units • Field hospitals in public spaces such as parks • Shell space in converted facility for future expansion

Figure 7 —Flexibility health care exemplars



Versatility

No physical modification; new functionality

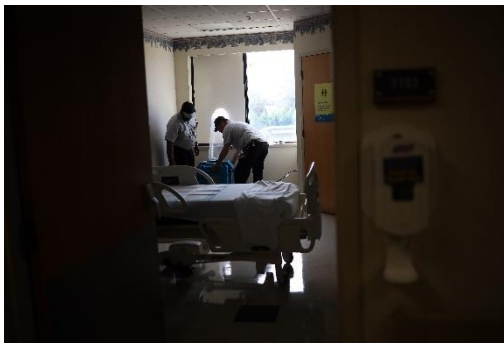
Screening at parking lot entrances



Modifiability

Minor modification with movable components

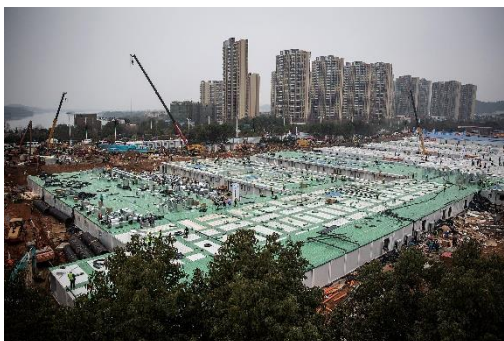
Lobbies as Screening Facilities by using mobile screens (Memorial Florida)



Convertibility

Major modification with infrastructure changes

Conversion to a negative pressure room (Medstar St. Mary's)



Scalability

Expand/contract with new or temporary construction

Rapid construction of new hospital facilities (Wuhan Huoshenshan Hospital)

Figure 8 —Flexibility alternative care facilities exemplars



Versatility

No physical modification; new functionality

Hotels for quarantine spaces (Scala Hotel)



Modifiability

Minor modification with movable components

Tents for screening in large parking lots (FedEx Field)



Convertibility

Major modification with infrastructure changes

Convention centers set up with patient beds (Javit Center)



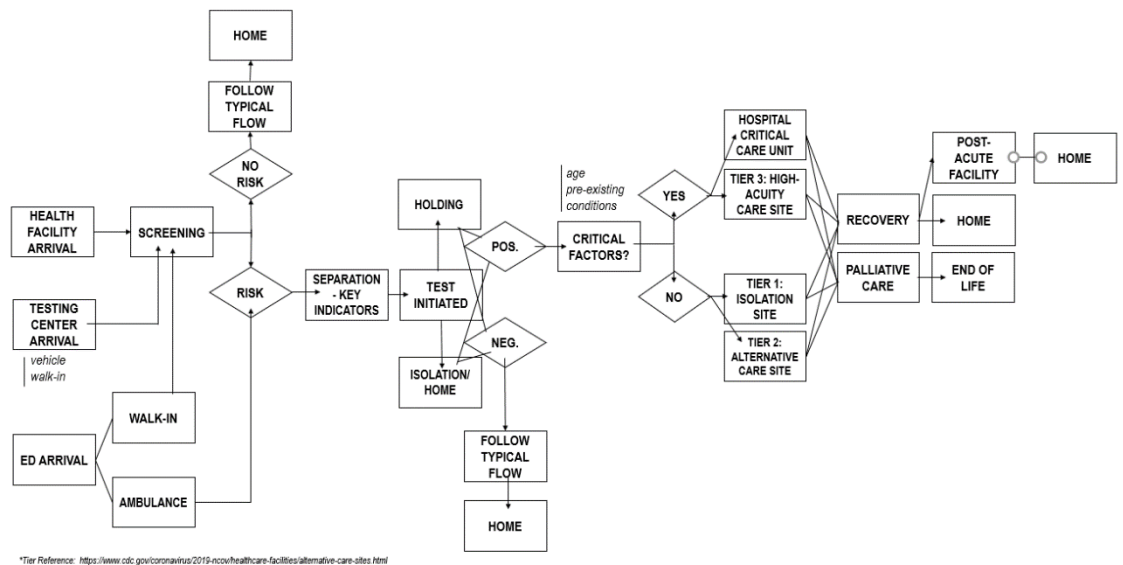
Scalability

Expand/contract with new or temporary construction

Field hospital constructed in wide open spaces (Central Park)

The added consideration of flow during a pandemic is imperative in both healthcare facilities (HCs) and alternative care facilities (ACFs) as a means for addressing infection control through planned space utilization. This component addresses air flow, resource flow, and people flow. An overall process flow, incorporating [the three tiers of care sites outlined by the CDC](#), is outlined below.

Figure 9— Understanding flow in a pandemic situation



The assessment of this flow diagram helps determine what kind of facility resources are deployed when. Today, functions are housed in temporary/ pop-up structures, existing healthcare facilities, ACFs modified for the needs of the pandemic, and rapidly constructed new buildings. The type of facility deployed for the specific function in a pandemic flow depends on how different systems and authorities are able to deploy flexibility. It requires a systematic road map which is laid out in the following section.

Figure 10— Response facility types



The Path Forward

Creating a Road Map for Flexibility

When responding to an EID, healthcare organizations must consider a phased approach that takes into account not only the immediate needs associated with the onset of an outbreak, but also how to navigate extended periods of treatment for large numbers of infected patients and manage the long term physical, emotional, social, and financial repercussions. The approach will differ for each healthcare organization based on their unique spatial, operational, and clinical constraints, and will most likely require a multitude of flex strategies to address both the short term and long-term needs associated with a pandemic disease.

As healthcare organizations quickly navigate the multiple waves of critical decisions associated with an EID, it is essential to have a proactive response plan that leverages systemic flexibility to seamlessly bridge existing healthcare infrastructure with available community resources. When developing a flexibility response plan, it is imperative to consider space and operations in concert to help mitigate potential negative downstream consequences. Consideration must also be given to resource constraints within the system, such as limited amounts of personal protective equipment, ventilators, and available clinical workforce, as these constraints will greatly impact the timing and type of design response employed.

Prioritizing the Need and Making a FleXX Plan

The very first step in developing a flexibility response plan to use data to assess needs and prioritize use of assets and resources. Early predictions are key in providing an accurate evaluation of existing capital assets and determining what type of facility should be deployed, when it should be employed, and the functions they should support.

The key variables that influence an informed calculation of how operations may need to change moving forward to accommodate the deployment of new facilities are:

- % of KPUs being conducted as virtual services/total services (total # of services conducted/# of virtual services conducted)
- Time to next available KPU (time till next touchpoint in treatment)
- Time to maximum capacity (time to: 80%, 90%, 100%, 100%+)
- Total # of available healthcare workers

- % of available healthcare workforce (total # of available healthcare workers/# of healthcare workers utilized)
- Total # of additional healthcare workers activated (inactive or retired licensed healthcare workers, national guard, students)
- Replacement Rate (total available healthcare workers/total # of healthcare workers infected, burned out, retired)

For design it's about determining all the available standard and surge capacities that can be made available:

- Time to activate (deploy) immediate solutions (e.g. pop-ups)
- Time to activate (deploy) secondary solutions (modify existing spaces)
- Time to activate (deploy) convert soft spaces (shell space)
- Time to activate (deploy) non-traditional venue (e.g. hotels)
- % of community resources utilized (total number of available community resources/number of community resources utilized)

Early predictions help to formulate decisions in wave 1 that focus on how to free up existing space within the hospital to increase critical care capacity, while continuing to provide essential services to non-infected patients. The data can be utilized to address questions such as: What procedures can be placed on hold? How do we manage the financial fallout from loss of revenue? Where can staff who are no longer providing those services be redeployed within the system?

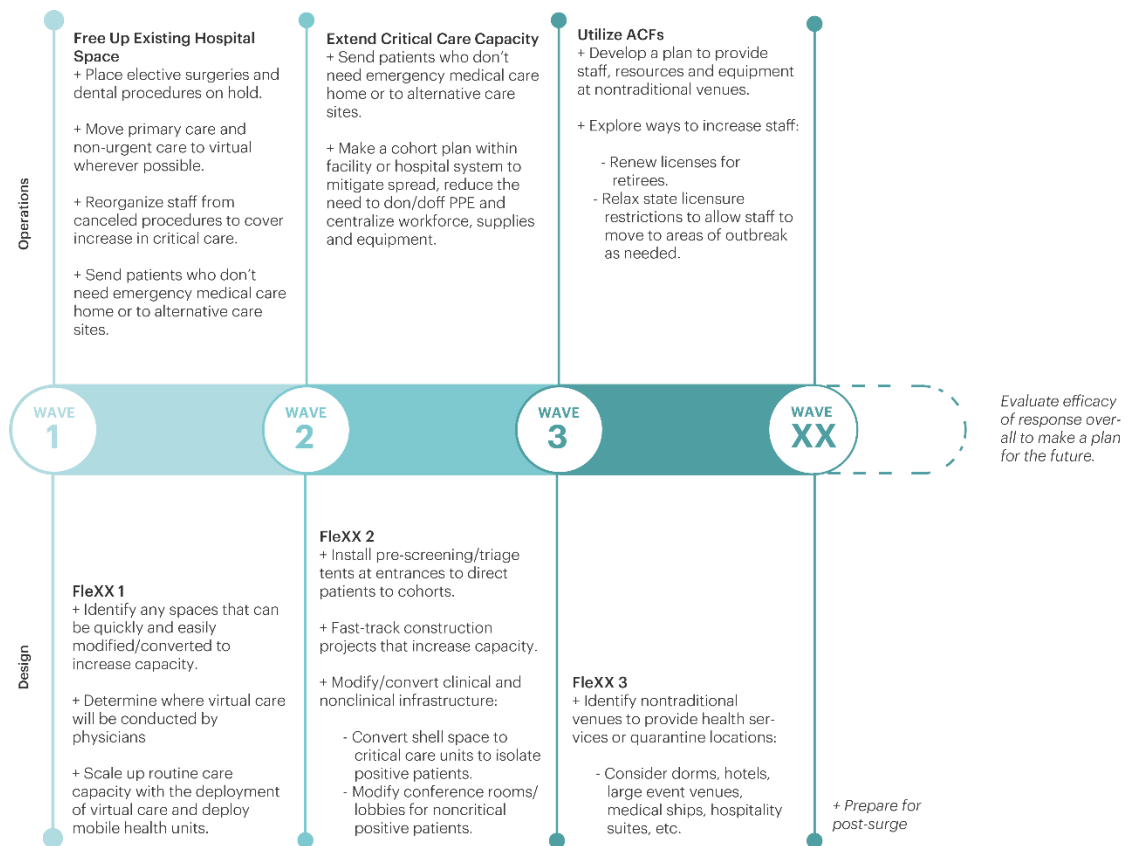
These predictions also help provide insight into the second wave of decision-making, which focuses on how to extend critical care capacity within the walls of the healthcare organization's own system by either quickly modifying or converting existing clinical and non-clinical infrastructure to meet increasing demand. Questions that can be asked of the data to support those decisions are: What is the best way to cohort patients of like acuity within the facility? What areas within existing facilities can be quickly modified to provide critical care services? Are there any existing construction projects that should be fast tracked? Do we have enough supplies and equipment to support the additional capacity? Do we have enough people to manage the additional capacity? What precautions are needed to ensure staff safety while taking care of infectious patients?

The third wave of decision-making focuses on how to extend beyond traditional healthcare settings into ACFs to meet excess demand. When considering ACFs it is important to

address questions such as: What existing community resources could be utilized as an ACF? How will necessary supplies and equipment get distributed across multiple ACFs? What additional staff will be needed to provide services across multiple ACFs?

To deploy flexibility in any city, county or system, we need to have a flexibility response plan. One that accounts for how you can flex your space, your resources and your staff, while managing the flow that limits/ contains the infection. We suggest using the framework below to decide what is the right plan for your system in mobilizing your strategy for both operations and the built environment during this time.

Figure 11— FleXX Plan during a pandemic



Modified from: <http://www.cadresearch.org/flexx>

While early predictions can help to answer some of these questions, it is also crucial to assess the feasibility of implementing different types ACFs to understand how to best leverage community resources.

Assessing Feasibility of Creating Alternate Care Facilities

To assess the feasibility of converting existing community resources into ACFs, it is important to determine 1) how the facility will be used and 2) how easy the facility can convert to support the intended use. Ease of change takes into account whether the facility will provide health services or serve as a quarantine location, facility size, required resources, and the amount of time it might take to mobilize any of these solutions. For example, some facilities such as hotels may be easily converted to serve as a containment or isolation facility, but not as easily converted to provide critical care for COVID-19 positive patients that require ventilator support. [The CDC Guidelines for ACFs](#) provide an excellent set of criteria that can serve as a guideline.

The following table provides an additional framing based on ease of change for a variety of ACFs to adapt to provide testing/screening, containment/isolation, and critical care and notes on how some of those typologies have begun to implement flex strategies. For each healthcare organization the ease of conversion for an ACF will differ. It is important to consider the following framework below to support value-based decision making when deciding what type of ACF to deploy and when based on each healthcare organization's unique situation during a pandemic.

Figure 12— Assessing ease of flexibility in alternative care facilities

Level of ease ranked: 1 – 5 (Easy – Difficult)	Testing/Screening		Containment/Isolation		Critical Care		FleXX Notes
	Facilities Conversion	Deploy Operations (personnel and supplies)	Facilities Conversion	Deploy Operations (personnel and supplies)	Facilities Conversion	Deploy Operations (personnel and supplies)	
Hotels							Lobby, ballrooms, guest rooms, and required facilities provide multiple spaces for care and support
Convention Centers							Provides large open spaces, smaller subdivided ones, and support facilities
Sports Stadiums							Large open space with support facilities
Dormitory							Individual rooms with support facilities
Academic Buildings							Large venue spaces, lecture halls, and gyms
Post-Acute Facilities							Nursing homes, rehab facilities, etc. Include some necessary infrastructure
Parking Lots/ Structures							Provide drive-through access, or open space for temporary facilities
Parks/ Open Civic Space							Large open space, equitably accessible
Trains							Able to retrieve and relocate patients from far distances
Athletic Clubs (YMCA)							Provides large open spaces and smaller subdivided ones as well

Post-Surge Preparedness

While responding rapidly to the needs during a surge, we also need to ensure that as we have a mid-term and long-term strategy in place. Prioritizing what ancillary health assets and community assets should be flexed, and when, is critical. It’s also important to keep, at the back of our mind, how we will flex back- or have post-surge preparedness. We must prepare for the inevitable physical, emotional, social, and financial fallout that comes with experiencing a pandemic like we are seeing today with coronavirus. This must be considered in the leveraging of existing or alternate facilities.

Starting a Conversation

A body of evidence doesn't exist on how to respond to such a pandemic- because we have not faced something similar in recent times. Looking at precedents from 1918, or the plague, can only take us this far.

We put this document out as an open-source mechanism to create a dialogue in the industry. The research community makes a commitment to a measured and thorough study as our first responders - healthcare workers, construction workers, essential service workers - respond as rapidly and responsibly as they can to this crisis, so we are better prepared, in our built environments.

Our rapid deployments of flexibility will tell us much about how we must plan for it going further and commit to a foundational resiliency and agility in our thinking. **We welcome all feedback, edits and inputs to this document (email admin@cadresearch.org), and hope you will help us add to our inventory of projects in this [live excel sheet](#).**

Notes from the Field

Responding to a pandemic is not without bumps in the road. As facilities adapt to changing needs, we are conducting e-interviews with systems and designers to understand the challenges they are facing and the solutions they have developed to address them.

We are sharing these challenges anonymously so we can all share and learn together. We welcome any designer or system that has developed successful solutions to their challenges to reach out to us at admin@cadresearch.org for an interview.

HOSPITAL A

COVID-19 ED screening and triage structures

Challenge: triage patients outside of the emergency department to

- (a) avoid unnecessary access to the emergency department area
- (b) cohort 'at-risk' patients
- (c) protect HCP
- (d) encourage and direct to home care instructions

Solution: Tent temporary structures to organize on-way flow of patients, provide for HCP proper use of PPE, provide for adaptability of spaces and flow to respond to escalating situation.

- Tents were pre ordered at dimensions that fitted open parking areas
 - Design and clinical teams positioned tents on site and planned key flow points: (public / staff entrances, patient dispatch to
 - Use of movable privacy partitions and WOWs to allow for space adaptability
 - Elevated and leveled flooring to avoid stormwater
 - Preference for usage of drop-off canopy areas where available to avoid stormwater and allow for ED connection
-

HOSPITAL B (System)

Surge patient units

Challenge: Explore soft space areas inside the hospitals to accommodate large multi-bed patient units for:

- (a) grouped non-positive patients to decant from private beds
- (b) non-critical patients potentially transferred from institutions that get decommissioned by the pandemic as assisted living and nursing homes
- (c) understand the needs and implications of accommodating overflow of COVID positive or PUI patients

Solution: Utilize conference centers, training rooms, rehabilitation gyms

- Phase 2A: Establish bed spacing as per FGI multi-bed (5' between beds)
- Maximize bed count
- Modulate bed positioning to allow for proper staff and resource distribution
- Plan standard 2x4' support modules in unit layout to allow for placement of wire shelving and/or documentation stations
- Assess power/data infrastructure and position Pyxis dispensers accordingly
- Trace the waste stream

Implementation: Utilize conference centers, training rooms, rehabilitation gyms

- 180 beds at Hospital B.1: conference center and adjacent parking structure

- 80 beds at Hospital B.2: GME classrooms and auditorium
 - 45 beds at Hospital B.3 Children's Hospital: training room, conference rooms and decanted patient holding in imaging and surgery
 - Hospital B.4 and Hospital B.5: under study
-

HOSPITAL C

ED surge unit

Challenge: plan implementation of deployable Zumro patient unit to serve as ED overflow unit.

Solution: Utilize canopy area to allow for connection to existing ED and recently installed screening/triage tent

- Reroute drop-off lane
 - Connect surge unit to screening unit
 - Elevate and level floor to avoid stormwater
-

HOSPITAL D

Ronald McDonald House converted into COVID-19 patient unit

Challenge: Maximize A.I.I. patient rooms by utilizing existing suites on upper floors and utilize 1st floor for logistics and patient intake procedures.

Solution: Explore installation of temporary air scrubbers to allow for air isolation

- Utilize one suite for a nursing station, provide clean supplies and medication on each floor
- Install a waster and linen shut to optimize waste stream

Additional Needs: open, unconditioned hallways need to be enclosed and conditioned as negative pressure rooms will pull air from hallways. Non-compliant with various codes and regulations.

HOSPITAL E-1

Limit exposure at pediatric outpatient center

Challenge: High volume of pediatric outpatient visits (500+/-) per day creates risk for care givers, patients and families.

Solution: Limit exposure.

- Cancel elective visits (telehealth alternatives)
 - Screening at entry points
 - 'Well patients' go to public elevators (limited to one family per ride)
 - Patients or families of concern use staff elevators – head directly to exam room without stopping in any waiting areas
 - Limit unnecessary visitors (contractors, staff, etc.) with virtual meetings
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HOSPITAL E-2

Increase bed license capacity

Challenge: Expected surge in COVID-19 patients when state peaks in early May that will result in a shortage of beds. Certificate of Need location on the east coast

Solution: Request additional inpatient bed licenses to increase capacity by ~ 50%.

- 150 Beds at Main Campus – critically ill patients
- 180 Beds in Dormitory -
- 130 Beds in Community Hospital

Additional Information

Date initially posted

April 2, 2020

Critical Sources

Original FleXX Study

<http://www.cadreresearch.org/flexx>

Infection Control Basics:

<https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html>

Infection Control Built Environment:

<https://www.healthdesign.org/topics/infection-control>

Alternate Care Facilities Guidelines:

<https://www.usace.army.mil/Coronavirus/Alternate-Care-Sites/>

<https://www.ashe.org/COVID19resources>

https://www.cdc.gov/coronavirus/2019-ncov/healthcare-facilities/alternative-care-sites.html?_lrsc=67375691-0658-44b9-8f86-e4e80e6bd967&utm_campaign=3627&utm_medium=social-elevate&utm_source=Elevate&utm_content=7303755-

Scenario Planning:

https://www.cdc.gov/cpr/readiness/healthcare/documents/discussion_guide_for_emergency_management.pdf

Facility Planning:

<https://www.ifma.org/know-base/coronavirus-preparedness-resource-center>

Palliative Care:

<https://www.capc.org/blog/role-palliative-care-covid-19-pandemic/>

<https://time.com/5812073/endof-life-coronavirus/>

Preparedness Scenarios:

<https://projects.propublica.org/graphics/covid-hospitals>

Post-Acute Care Preparedness:

https://jamanetwork.com/journals/jama/fullarticle/2763818?utm_source=twitter&utm_campaign=content-shareicons&utm_content=article_engagement&utm_medium=social&utm_term=032520#.XnuUdDMAcrt.twitter

Infection Estimates:

<https://www.cnn.com/2020/03/29/politics/coronavirus-deaths-cases-anthony-fauci-cnntv/index.html>

Response Resources:

<https://www.ashrae.org/technical-resources/resources><https://www.ashrae.org/technical-resources/resources>

Economic Optimization:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4284561/>

Sustainability and Pandemics:

<https://www.pnas.org/content/117/8/3888.short>

Coronavirus Spread:

<https://www.sciencedaily.com/releases/2020/03/200316143313.htm>